
CHAPTER 1

INTRODUCTION

1.1 NEED FOR THE ASSESSMENT

Title IV of the Clean Air Act Amendments of 1990 calls for a 10 million ton reduction in annual emissions of sulfur dioxide (SO₂) in the United States by the year 2010, which represents an approximately 40 percent reduction in anthropogenic emissions from 1980 levels. Implementation of Title IV is referred to as the Acid Rain Program; the primary motivation for this section of the Clean Air Act Amendments is to reduce acid precipitation and dry deposition.¹ This assessment has been prepared at the request of the U.S. Environmental Protection Agency (U.S. EPA), Acid Rain Division, to quantify the expected human health benefits associated with the SO₂ emissions reductions required under the Acid Rain Program. This assessment is intended to contribute to the assessments of costs and benefits of the Clean Air Act, such as the studies called for under Sections 812 and 901 of the 1990 Amendments. The Act requests that benefits and costs be quantified to the extent possible given available scientific and economic information. This report, therefore, focuses on quantification of potential health benefits of Title IV in both numbers of specific health effects expected to be reduced and their monetary valuation.

1.2 PURPOSE OF THE REPORT

This report provides estimates of the human health benefits expected to result from changes in ambient sulfate aerosol concentrations in the eastern United States. Title IV requirements are expected to result in significant reductions in SO₂ emissions in the eastern United States.² This will mean lower gaseous SO₂ concentrations close to major emissions sources, lower sulfate aerosol concentrations (including acid and nonacid aerosols) throughout the region, and lower acid precipitation throughout the region. This report focuses on ambient sulfate aerosols because the potential human health benefits of this pollutant reduction have not been fully quantified in previous analyses, because the potential human health benefits are substantial, and because a quantitative assessment is feasible for sulfate aerosols, given available scientific and economic information. This report does not attempt to quantify various other possible human health benefits of Title IV, such as those that might result from nitrogen oxide reductions and “piggy back” toxics or particulate reductions.

¹ Throughout this report the terms “acid rain” and “acid precipitation” include dry deposition.

² SO₂ emissions are also controlled under Title I of the Clean Air Act.

Sulfate aerosols are a substantial share of total ambient fine particulate matter in the eastern United States. A large body of epidemiology literature examines the relationship between ambient particulate matter and health effects. Some of these studies have specifically examined sulfate aerosols, and many more have examined more broad measures of particulate matter such as $PM_{2.5}$ (particulate matter with aerodynamic diameter of 2.5 microns or less) or PM_{10} (particulate matter with aerodynamic diameter of 10 microns or less). Scientific debate and uncertainty continue concerning the extent to which sulfates may or may not be the key causative constituent of this observed association between health effects and particulate matter. Sulfate aerosols, and especially that portion of sulfate aerosols that is acidic, continue to be considered one of the likely causative agents in the observed association between particulate matter and health effects in the eastern United States. In this assessment, the available epidemiology evidence is applied on the presumption that sulfate aerosols are at least a contributing causative constituent of $PM_{2.5}$. This assessment does not assume that sulfate aerosols are the only causative constituent of $PM_{2.5}$.

This assessment also relies on available economic information for estimates of willingness to pay (WTP) for changes in risks of specific health effects. Economic values for changes in risks of human health effects should reflect the full costs to the affected individual and to society. The full costs of an adverse health effect include financial losses such as medical expenses and lost income (referred to as the cost of illness), plus less tangible costs such as pain and discomfort, restrictions on nonwork activities, and inconvenience to others. WTP, as a monetary measure for a change in health risk, is defined as the dollar amount that would cause the affected individual to be indifferent to experiencing an increase in the risk of the health effect or losing income equal to that dollar amount. WTP measures of monetary value for changes in health risks thus exceed health care and other out-of-pocket costs that are associated with illness or premature death, because WTP reflects these as well as other less tangible effects of illness or premature death on a person's quality of life.

1.3 CONTEXT OF HEALTH BENEFITS

Health effects benefits due to reductions in ambient sulfate aerosols, which are the focus of this report, are just one category of potential benefits due to Title IV. The potential benefits of the Title IV provisions include a wide range of environmental impacts, including improvements or reductions in:

- human health effects
- effects on aquatics ecosystems, including effects on recreational fishing
- visibility aesthetics
- effects on materials
- effects on terrestrial ecosystems, including effects on forests and crops.

Each of these effects involves complex chemical, atmospheric, biological, psychological, and economic processes. Some of these processes are fairly well understood at this time and others are not. A practical and policy-relevant assessment must recognize the complexities and uncertainties inherent in current scientific knowledge of these processes, but it must also synthesize, simplify, and interpret available information into conclusions that will be useful for policy-makers.